

19

supply passageway 110 formed in the dome-shaped top portion of the quartz tube 102. To be more specific, in the embodiment shown in FIG. 22, the processing gas is introduced from the first gas supply passageway formed in the dome-shaped top portion of the quartz tube 102 directly into the quartz tube 102. However, it is desirable to employ the construction shown in FIG. 25 or 26 in order to allow the processing gas to be dispersed uniformly and promptly into the processing chamber. In the embodiment shown in FIG. 25, the processing gas is introduced through a plate member 121 having a plurality of through holes 120 formed therein so as to permit the gas to be dispersed uniformly and rapidly. On the other hand, in the embodiment shown in FIG. 26, a sponge-like porous member 122 is disposed in the vicinity of the first gas supply passageway 110. In this embodiment, the processing gas is introduced into the plasma generating section through micro pores 123 present in the sponge-like porous member 122 so as to permit the gas to be dispersed uniformly and rapidly.

FIGS. 27 and 28 collectively show an ECR plasma etching apparatus according to still another embodiment of the present invention. Some members of the apparatus shown in FIG. 27 are equal to those shown in FIG. 22 in the function and construction. The same reference numerals are put to these particular members in FIG. 27 and the description thereof is omitted in the following description.

In the apparatus shown in FIG. 27, a quartz plate 130 is arranged on the upper surface of the processing chamber 111 in place of the quartz tube 102 used in the apparatus shown in FIG. 22, and a substantially planar antenna 131 is arranged on the outer surface of the quartz plate 130. As shown in FIGS. 27 and 28, the antenna 131 is a substantially planar spiral antenna having multiple curved antenna segments (e.g., two, as shown in FIG. 28), each of which has an inner end positioned at the central area of the spiral of the spiral antenna. Each of the curved antenna segments is shaped such that it spirals outwardly from the inner end on a plane shared with the other segments. A high frequency current is applied from a high frequency power supply 105 to the spiral antenna 131 so as to permit the antenna 131 to form efficiently an alternating electric field. Incidentally, the shape of the antenna arranged on the outer surface of the quartz plate 130 need not be restricted to the spiral shape as shown in FIG. 28. In other words, an antenna of any optional shape can be used as far as a desired alternating electric field can be formed in a desired region.

In the apparatus shown in FIG. 27, an electromagnetic coil 106 is arranged to correspond to the spiral antenna 131, as in the embodiment shown in FIG. 22, making it possible to form a static magnetic field having lines of magnetic force gradually diverging vertically downward. It follows that the apparatus of the embodiment shown in FIG. 27 also permits forming an ECR region in a desired region, e.g., a region 20 to 30 cm above the processing surface of the object to be

20

treated, if the outputs of the antenna 131 and the electromagnetic coil 106 are controlled appropriately.

What should also be noted is that, in the apparatus shown in FIG. 27, it is unnecessary to use such a large member as the quartz tube 102 which is used in the embodiment shown in FIG. 22. It follows that the plasma processing apparatus can be markedly miniaturized.

What is claimed is:

1. A method for processing a substrate with plasma, comprising the steps of:

positioning the substrate in a processing chamber;

supplying a high frequency power to a substantially planar spiral antenna from a central area thereof and generating an induced electric field in the processing chamber;

generating a plasma in said processing chamber; and shaping said induced electric field with respect to said substrate so as to achieve a uniform distribution of said plasma on said substrate.

2. The method according to claim 1, wherein:

said supplying step includes supplying the high frequency power to the spiral antenna and impedance matching an output of a high frequency power supply to an input of said spiral antenna.

3. The method according to claim 1, further comprising a step of controlling a supply of the high frequency power by a controller.

4. The method according to claim 1, wherein:

said supplying step comprises,

generating an alternating magnetic field having flux lines that pass through a dielectric member disposed between said spiral antenna and said substrate in said processing chamber.

5. The method according to claim 1, wherein:

said supplying step comprises,

supplying the high frequency power to said spiral antenna which includes a plurality of curved antenna segments having inner ends which are positioned at the central area.

6. The method according to claim 5, wherein:

said supplying step comprises,

supplying the high frequency power to said curved antenna segments, each of said curved antenna segments spiralling radially outward in a same direction, said direction being either clockwise or counter-clockwise.

7. The method according to claim 1 wherein:

said shaping step includes,

disposing a paramagnetic plate under said spiral antenna.

* * * * *